2019511

DEPARTMENT OF
TOXIC SUBSTANCES CONTROL
8800 CAL CENTER DRIVE
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(916) 255-3545

TRANSMITTAL LETTER

DATE: 02-11-03

PLEASE DELIVER

TO: Mr. Steve Armann
WST-4
USEPA REGION 9
75 Hawthorne Street
San Francisco, CA 94105

K.B. 2/14/03
John Beach
Files

FROM: Peter Bailey Phone: (916) 255-3602

ENCLOSURE:

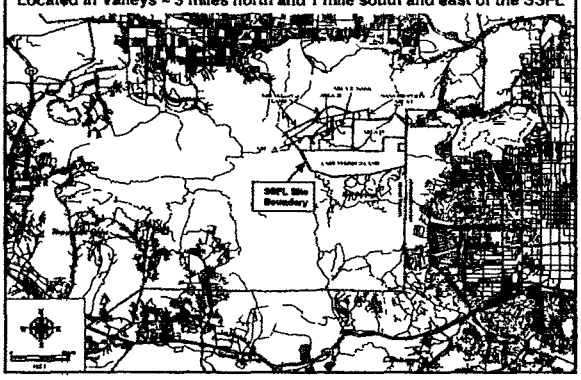
Mr. Armann, Rick Moss requested that I send you a copy of this presentation about perchlorate.

If you have any questions, please give me a call.

Peter

2019511

SSFL Is Located Atop the Simi Hills with Residential Communities Located in Valleys ~ 3 miles north and 1 mile south and east of the SSFL



Why isn't SSFL Perchlorate Source?
Topics to be Covered

- Rocket Propellant Basics
- Perchlorate Usage at the SSFL
- Occurrences of Perchlorate at SSFL
- Plausible Transport Mechanisms
  - Atmospheric Deposition
  - Surface Water
  - Groundwater
- Evaluation of Atmospheric Deposition
- Evaluation of Surface Water Transport to Simi Valley
- Evaluation of Groundwater Transport at the SSFL
  - Distribution of Perchlorate in SV Groundwater
    - Other Plausible Sources
  - Perchlorate Occurrence in Ahmanson Ranch Well M-1
- Summary

Why isn't SSFL Perchlorate Source?
Topics to be Covered

- Rocket Propellant Basics
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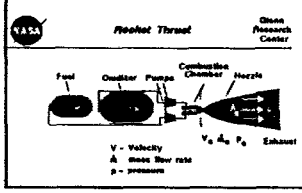
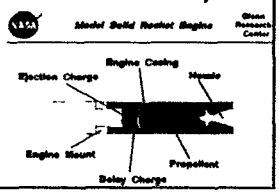
Many Rocket Engines were Tested at the SSFL, Wasn't a Lot of Perchlorate Used?

There are two basic types of rocket propellants:

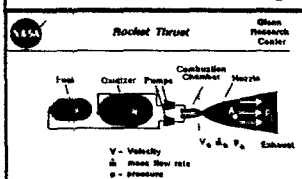
Liquid Propellants
(e.g., kerosene)



Solid Propellants
(can use perchlorate as the oxidizer)

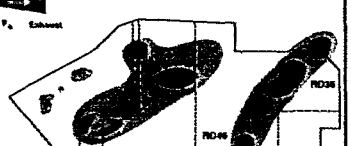


Liquid Rockets that Used Kerosene as the Fuel Required Flushing with TCE for Safety



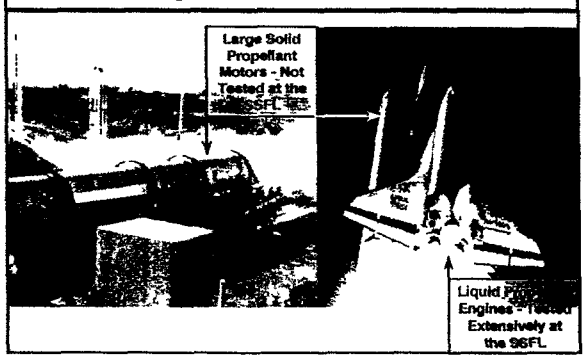
Six Test Areas Operational in Late 50's

- 17,000 Engine & Component Tests
- 400,000 - 800,000 gal TCE discharged



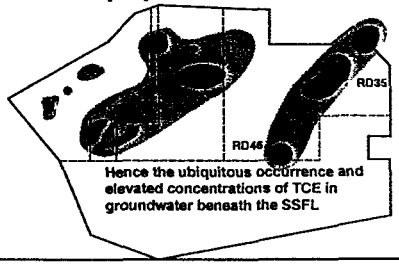
Hence the ubiquitous occurrence and elevated concentrations of TCE in groundwater beneath the SSFL

Solid Propellant Motors for Lifting Spacecraft Into Orbit are Large and were not Tested at the SSFL



Rocket Propellant Basics - Key Point

- **Liquid propellant engines were/ are tested at SSFL (significant historical TCE use), not solid propellant motors**



Hence the ubiquitous occurrence and elevated concentrations of TCE in groundwater beneath the SSFL

Why isn't SSFL Perchlorate Source?
Topics to be Covered

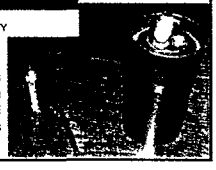
- Perchlorate Usage at the SSFL

Some Small Rockets with Solid Propellants *Were* Tested at the SSFL

Rockets Tested were for Military Munitions and Other Research-Related Activities

Perchlorate was Used as an Oxidizer

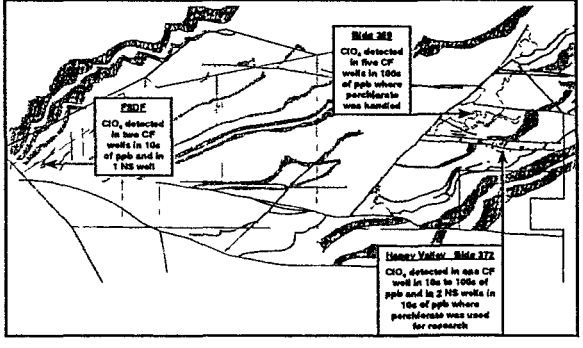
Folding Fin Aircraft Rockets (FFAR) NALAR LAR NAKA, & NASTY



Perchlorate was/is also used as an oxidizer to ignite fuel pumps

ClO_4 has been Detected in Groundwater Beneath the SSFL Coincident with Where it was Handled/ Used

Samples from all other wells (>200) and springs (~12) surrounding these isolated detections did not contain perchlorate



Why isn't SSFL Perchlorate Source?
Topics to be Covered

- Occurrences of Perchlorate at SSFL

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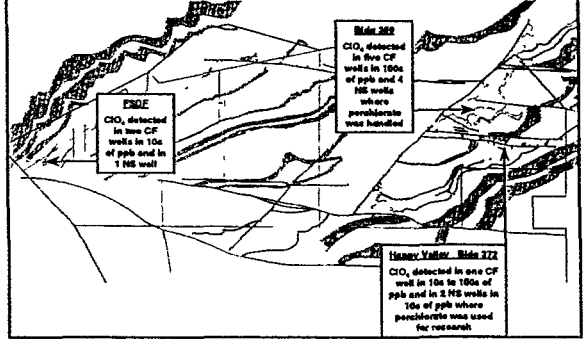
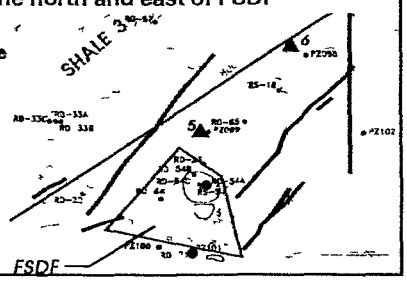
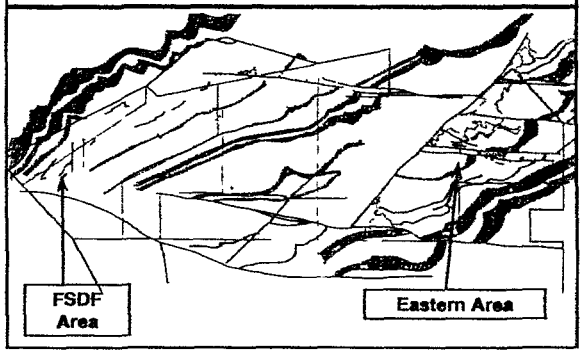


Analysis of Samples from Groundwater and Springs Shows Small Local Release

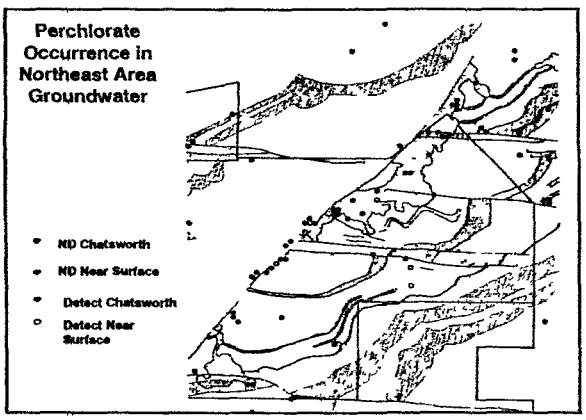
- Shallow and deep groundwater at FSDF
- Springs to the north and east of FSDF
  - DTSC
  - Rocketdyne



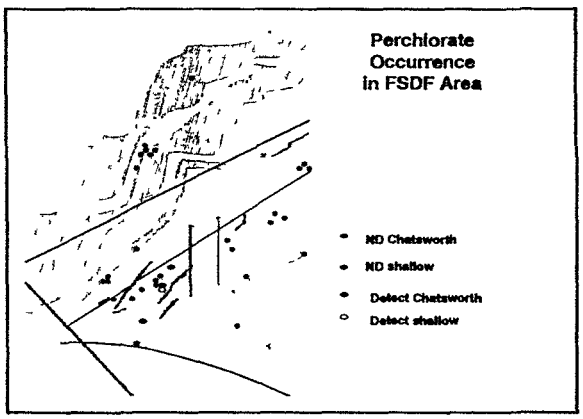
Distribution of Wells That Do Not Contain Perchlorate



Perchlorate Occurrence in Northeast Area Groundwater

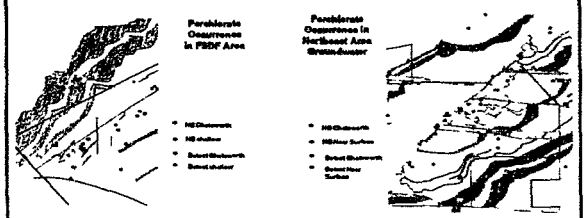


Perchlorate Occurrence in FSDF Area



Occurrences of Perchlorate at SSFL - Key Points

- Perchlorate is found coincident with where it was used
- Samples from locations peripheral to where it occurs at the SSFL do not contain perchlorate ⟶ localized releases



Why isn't SSFL Perchlorate Source?
Topics to be Covered

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- Plausible Transport Mechanisms
  - Atmospheric Deposition
  - Surface Water
  - Groundwater
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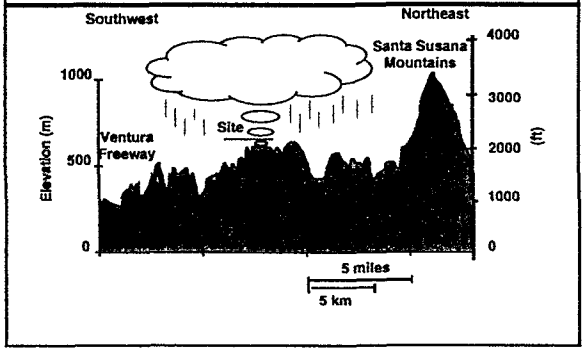
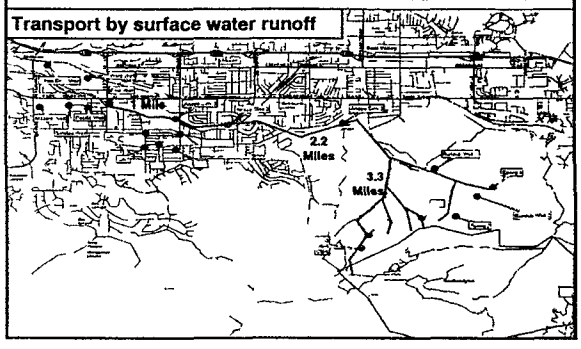
Concept of Atmospheric Deposition of Perchlorate

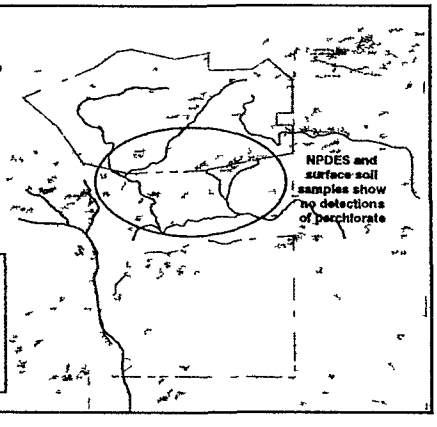


For perchlorate, SSFL to Simi Valley transport concepts include the following:



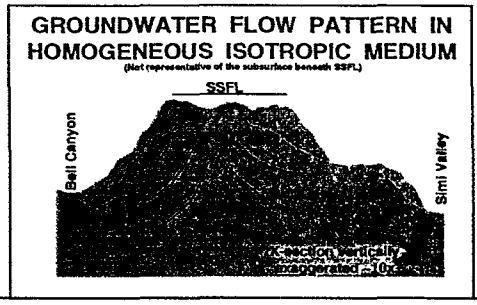
For perchlorate, SSFL to Ahmanson Ranch transport concepts include the following:

Transport by surface water runoff. separate and distinct drainages

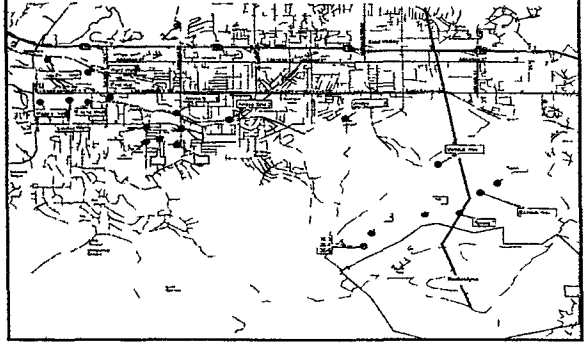


For perchlorate, SSFL to Simi Valley transport concepts include the following:

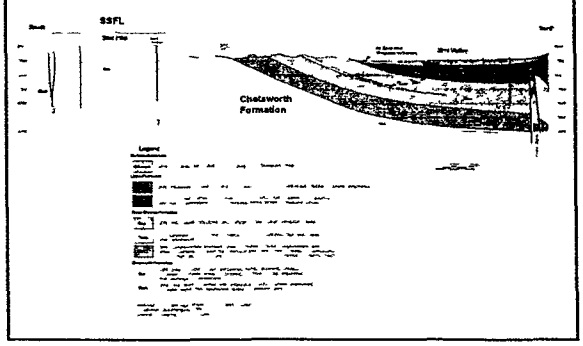
- Transport by groundwater



Cross-Section Reflects the Unrealistic Scale of Groundwater Transport

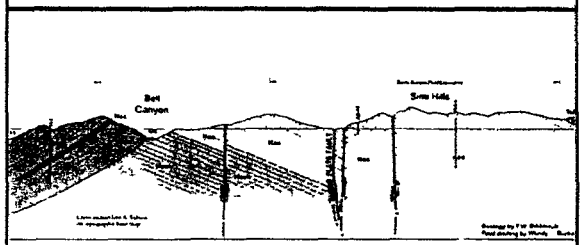


Cross Section Shows the Scale of the Groundwater Flow System from SSFL to Simi Valley



Cross-Section Reflects the Unrealistic Scale of Groundwater Transport

Cross Section Shows the Scale of the Groundwater Flow System from SSFL to Ahmanson Ranch



Plausible Transport Mechanisms - Key Points

- **Atmospheric Deposition**
  - Concept of emissions to atmosphere and redeposition onto ground with subsequent infiltration
- **Surface Water**
  - Surface water transport distances to Simi Valley are between 3 and 5 miles away
  - Surface water drainages between SSFL and Ahmanson Ranch are separate and hydraulically distinct
- **Groundwater**
  - Transport requires flow through miles of complex subsurface geology

Why isn't SSFL Perchlorate Source?
Topics to be Covered

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- Evaluation of Atmospheric Deposition
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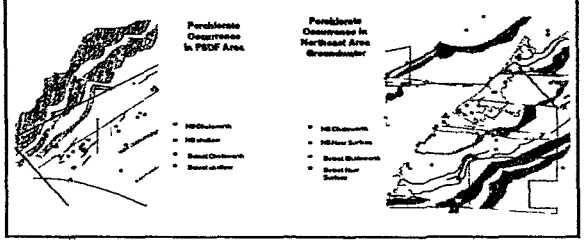
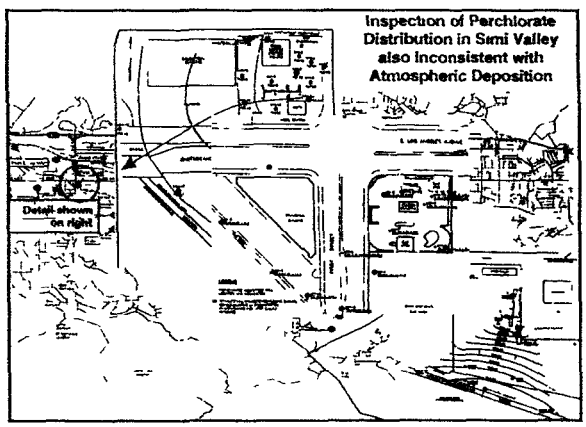
Inspection of On-site Perchlorate Distribution Inconsistent with Atmospheric Deposition

- Many wells ND, not indicative of wide-spread distribution associated with atmospheric deposition





Atmospheric Deposition of Perchlorate - Key Point

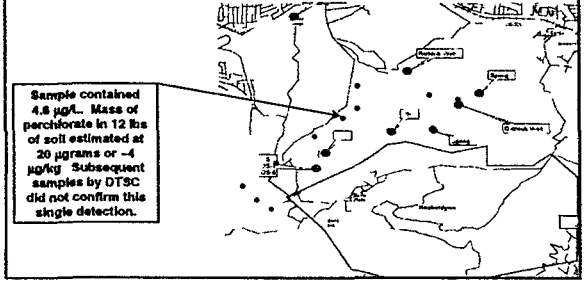
- Inspection of the distribution of perchlorate in wells located on- and off-site does not reveal a pattern indicative of atmospheric deposition
  - Detections are sporadic and without a systematic pattern

Why isn't SSFL ClO_4 Source?
Topics to be Covered

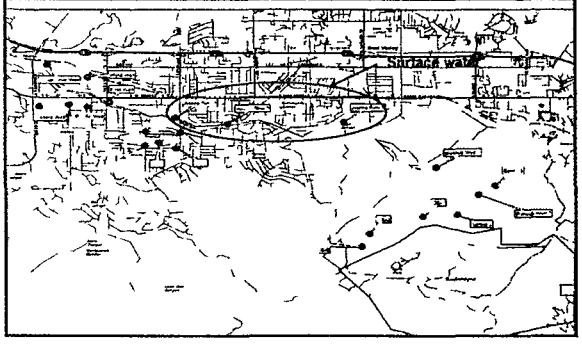
- Evaluation of Surface Water Transport to Simi Valley

Soil Leachate Sampling from SSFL & Adjacent Drainages are Almost All ND

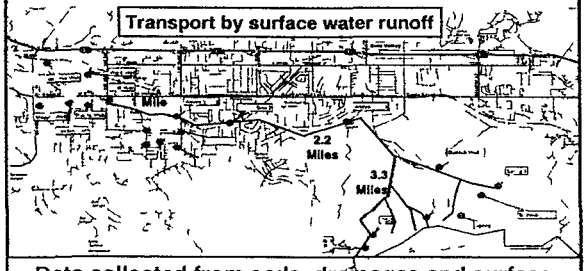
- DTSC Collected Soil Leachate Samples from Meier and Runkle Canyon Drainages - All but one ND



DTSC's Sampling of Surface Water from Arroyo Simi Showed No Perchlorate to be Present



Summary of Perchlorate Occurrences in Simi Valley and Likelihood of Transport from SSFL



Data collected from soils, drainages and surface water show that the SSFL is not the perchlorate source to SV groundwater

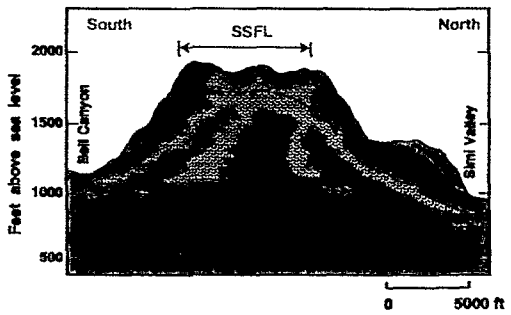
Evaluation of Surface Water Transport - Key Point

- Extensive sampling of surface water and drainages discharging to Arroyo Simi, show this transport pathway to be incomplete

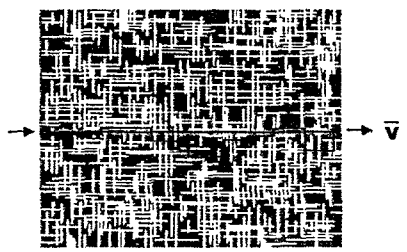
Why isn't SSFL ClO_4 Source?
Topics to be Covered

- Evaluation of Groundwater Transport at the SSFL

Intuitive Viewpoint Concludes Distant Contaminant Transport
(Assuming homogeneous & isotropic geology, which are not SSFL conditions)



Average Linear Groundwater Velocity



$$\bar{v} = \frac{K_b\,[\Delta h / \Delta L]}{\phi_f}$$

where ϕ_f = bulk fracture porosity
K_b = bulk hydraulic conductivity

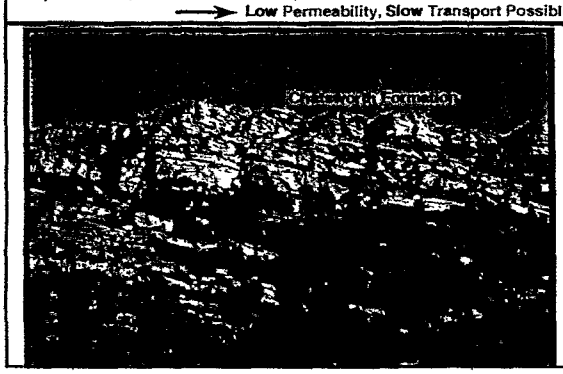
Calculations Show Average Linear Groundwater Velocity in Moderately Permeable Sandstone to be High

$$\bar{V} = \frac{\text{Darcy Flux}}{\text{Fracture Porosity}} = \frac{K_b\,(dh/dL)}{\phi_f}$$

K	10^{-4} cm/s
dh/dL	0.01
ϕ_f	0.001

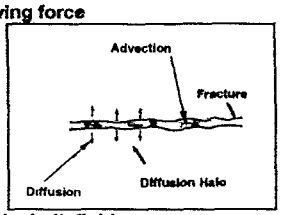
$\bar{v} \approx$ 1000 feet per year

Closer Inspection Revealed
Many Fractures, Shallow Water Table,
→ Low Permeability, Slow Transport Possible



Two Contaminant Transport Processes

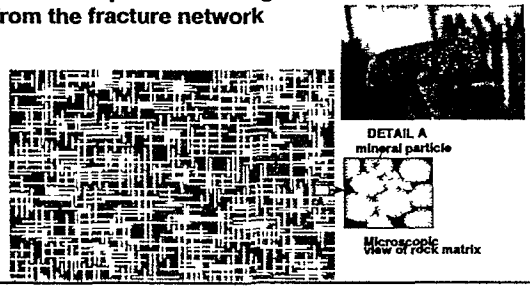
➢ Advection
- Bulk fluid movement (water, air, DNAPL)
- Hydraulic gradient as driving force
- Darcy's Law (1856)



➢ Diffusion
- Solute movement *within* the bulk fluid
- Chemical concentration gradients as driving force
- Fick's Law (1852)

Matrix Has Large Porosity

Physical characteristics of the rock matrix allow transport and storage of chemicals from the fracture network



Science Shows that the Transport of Other Non-sorbing Contaminants is also Retarded due to Diffusion

Journal of Hydrology 25 (1975) 159—166
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THE CHALK GROUNDWATER TRITIUM ANOMALY — A POSSIBLE EXPLANATION

S.S.D. FOSTER
Hydrogeological Department, Institute of Geological Sciences, London (Great Britain)
(Received August 30 1974 accepted September 3, 1974)

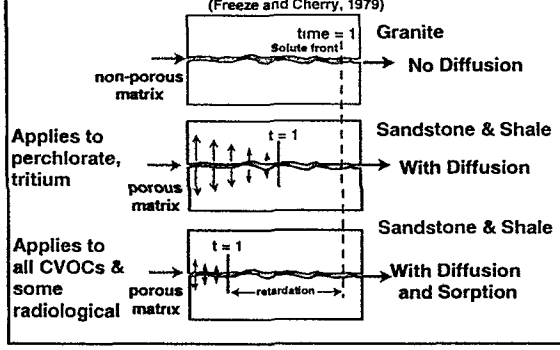
ABSTRACT

Foster S.S.D. 1975. The Chalk groundwater tritium anomaly — a possible explanation. J. Hydrol., 25: 159—165

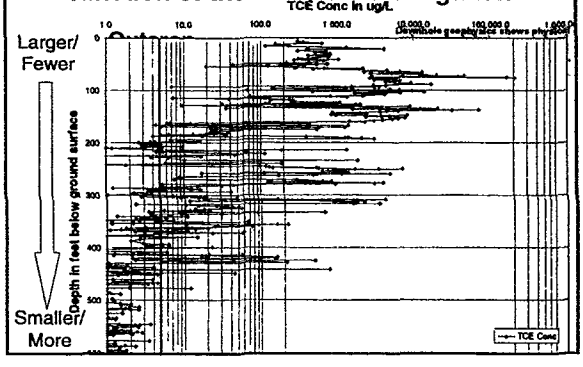
Attention is drawn to a mechanism which could profoundly complicate the interpretation of tritium determinations in investigations of the rate of groundwater movement in the British Chalk and other physically-comparable formations. It could explain the anomalously low levels of thermonuclear tritium currently observed in the saturated zone of the Chalk aquifer, with important implications for pollution control.

Slow Transport in Sandstone can be Caused by Matrix Diffusion and Sorption

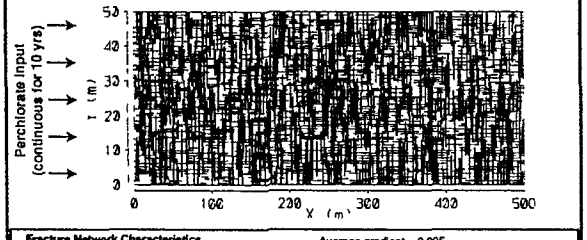
(Freeze and Cherry, 1979)



Fracture number/spacing/aperture is a function of the scale of investigation



2-Dimension Fracture Network Simulations Provide Insight into Perchlorate Transport in the Fractured Chatsworth Formation that Underlies the SSFL

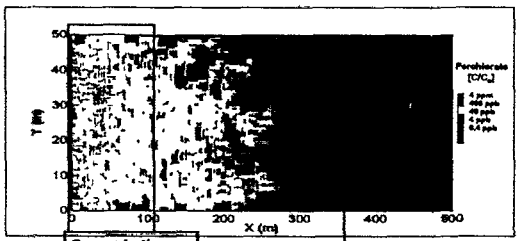


Fracture Network Characteristics:
Main Aperture = 100 µm (variable apertures)
Overall Bulk Hydraulic Conductivity K_b = 6.2x10^{-3} cm/sec
Bulk Fracture Porosity ϕ_f = 1.2x10^{-4}

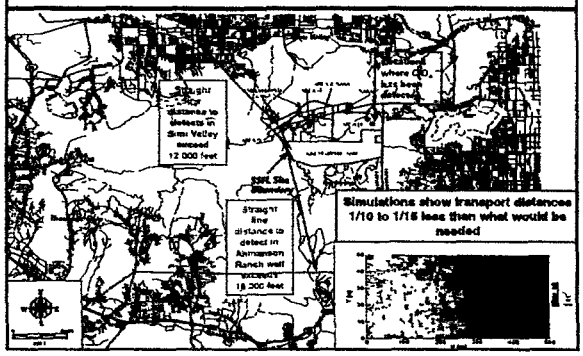
Average gradient = 0.005
Average linear groundwater velocity ~ 720 m/year

Characteristics derived from data collected at the SSFL

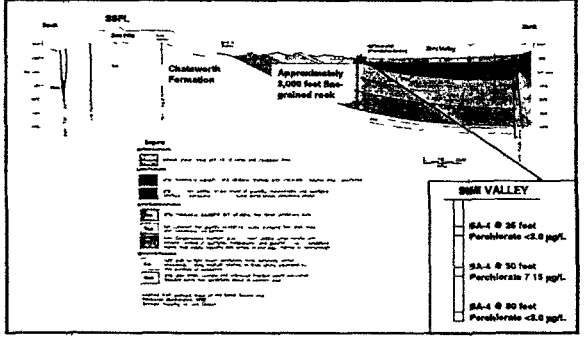
Perchlorate Contours @ 50 years from Time of Initial Release Likened to Present Day with Initial Release in 1950



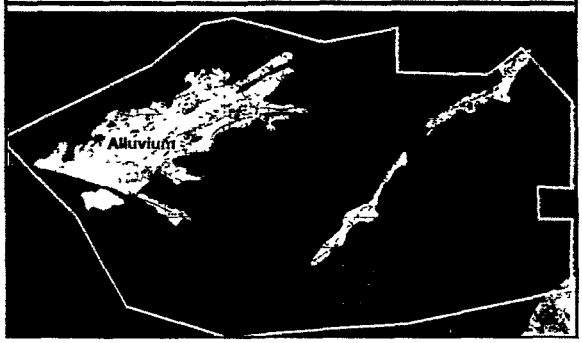
Diffusion of ClO_4 into the Fractured Rock Matrix Retards Transport Even Though Sorption Plays No Role



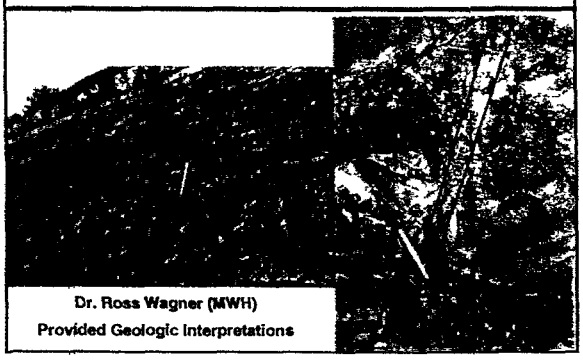
Groundwater Data from Simi Valley Show Deeper Groundwater is Not Impacted



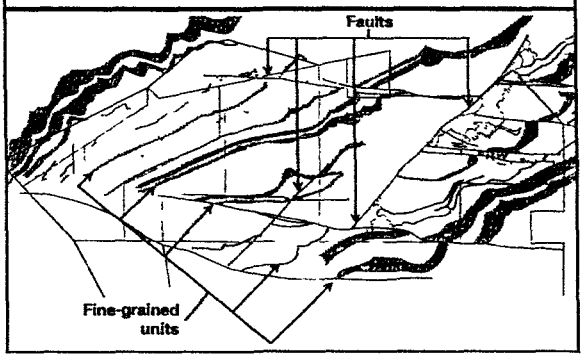
Earlier Geologic Interpretations Indicated a Single Sandstone Unit & Faults as Preferred Flowpaths



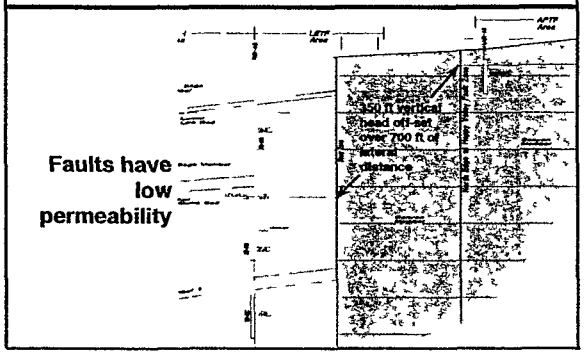
Fine-grained siltstones, shales and fault gouge are geologic features with lower permeability → Opposite of preferential flow paths



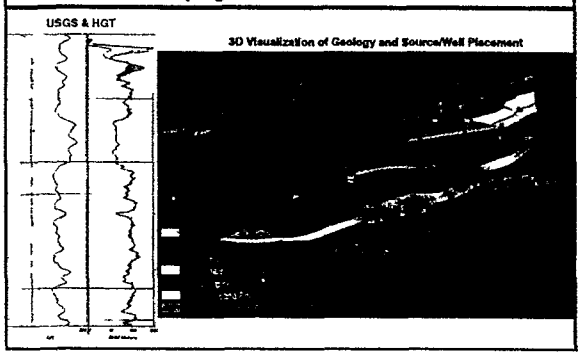
Detailed Review and Inspection of Geologic Framework Shows the Presence of Many Fine-Grained Features



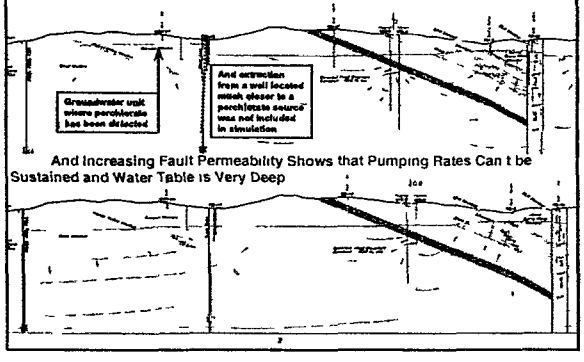
Analysis Shows Large Off-sets in Hydraulic Head Across Faults and Other Fine-Grained Features



Downhole Geophysical Logs Provide Control for Establishing Extent and Location of Fine-Grained Features and for Developing the 3-D Visualization of Site Data



2-D Flow Simulations Provide Insight into the Effect of Historical Pumping on the SSFL Flow System



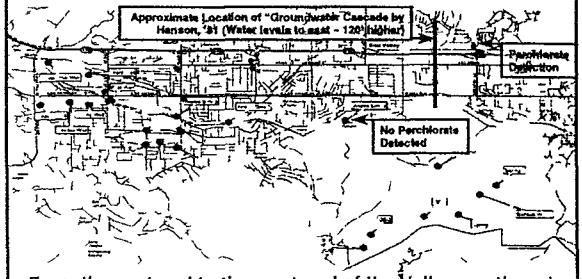
Evaluation of Groundwater Transport at SSFL - Key Points

- Transport of non-sorbing solutes at SSFL is fundamentally different from granular aquifers
- Transport of perchlorate solute in groundwater is slowed due to molecular diffusion which simulations show transport distances of ~1000 feet after 50 years of releases
- Fine-grained stratigraphic units and fault gouge slows the flow of groundwater and isolates perchlorate occurrences
- Historical pumping at water supply wells captured any groundwater containing perchlorate

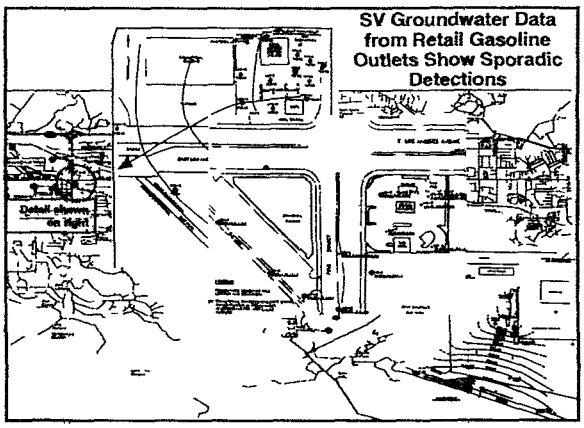
Why isn't SSFL ClO_4 Source?
Topics to be Covered

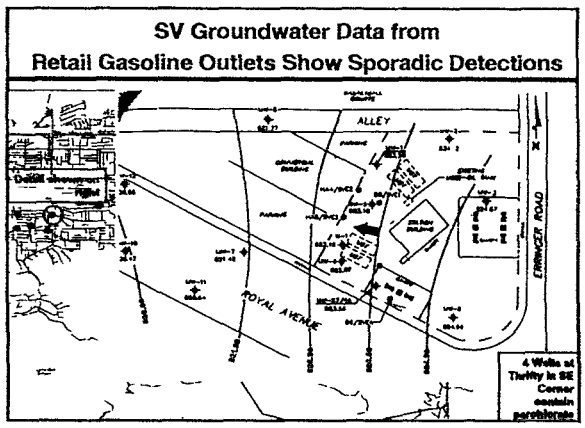
- Distribution of Perchlorate in SV Groundwater

Where has perchlorate been found in groundwater beneath the Simi Valley?



From the east end to the west end of the Valley, north and south of Arroyo Simi, sporadically, at very low concentrations (less than 20 parts per billion), in unused shallow groundwater





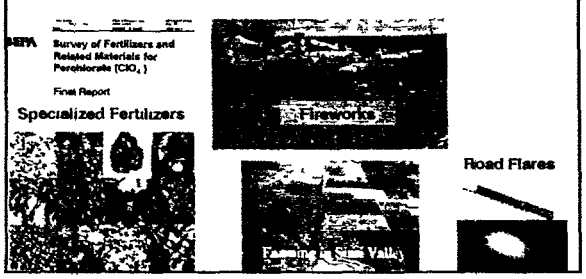
Distribution of Perchlorate in Simi Valley Groundwater - Key Point

- **Distribution in Simi Valley groundwater is inconsistent with any plausible SSFL release scenario**

Why isn't SSFL ClO_4 Source?
Topics to be Covered

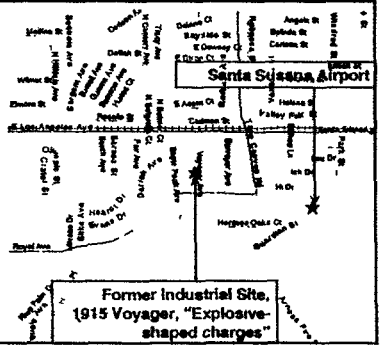
- Other Plausible Sources

Other Plausible Sources of Perchlorate in Simi Valley Groundwater Include:



The Occurrence of Perchlorate at Various Distinct Locations in SV Groundwater Leads to Multiple Sources

- **Other sources are also more plausible than SSFL**
  - Industrial
    - Former Site
    - SS Airport
  - Imported water from Colorado River



Other Types of Point Sources Also Contain Perchlorate

MSDS for Fireworks

MATERIAL SAFETY DATA SHEET & EMERGENCY RESPONSE INFORMATION

FIREWORKS, UN0336 (EXPLOSIVE 1.4G)
(Formerly classified as CLASS C EXPLOSIVES Common Fireworks)
(Also known as Consumer Fireworks)

American Promotional Events, Inc
dba TNT Fireworks
555 N. Gilbert Street
Fullerton, CA 92833
(714) 738-1002

"Yes, potassium perchlorate is in the "oxidizer mixture.""
TNTFireworks

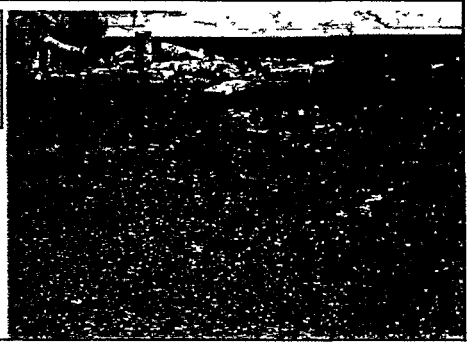
DATE PREPARED: March 27 2001

HAZARDOUS INGREDIENTS/IDENTITY INFORMATION
Hazardous Components: Contains pyrotechnic composition a solid mixture of oxidizer and fuel that will burn if ignited These items are classified as Fireworks 1 4G UN0336 by the U S Dept. of Transportation No chemical composition is exposed during normal handling and storage

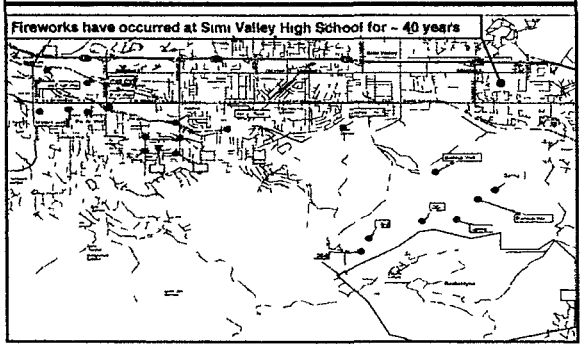
PHYSICAL/CHEMICAL CHARACTERISTICS
Solubility in Water: Slight
Appearance and Odor: All pyrotechnic composition is contained in a cardboard casing

Fireworks are Ubiquitous

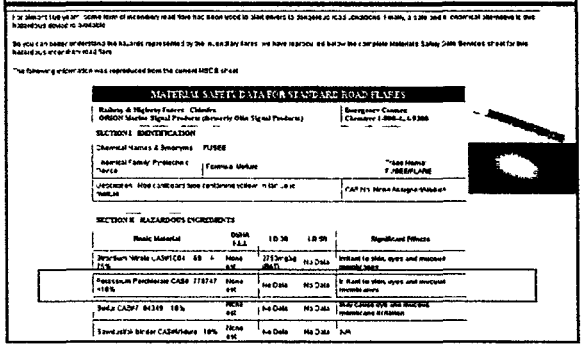
Photograph taken on Casarin St on July 5th, 2002 at 8:30 am



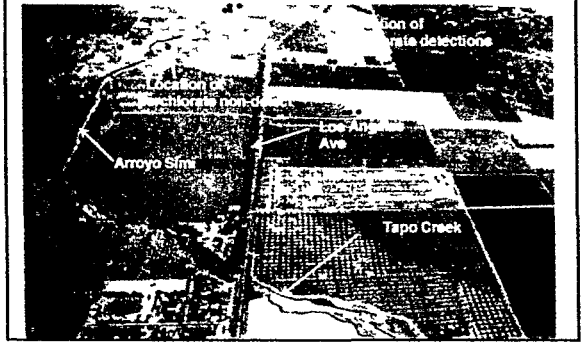
Fireworks are Ubiquitous



Road Flares Also Contain Perchlorate and Are Ubiquitous



The Historical Use of Fertilizers in the Simi Valley May be the Source of Perchlorate

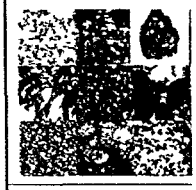


EPA's Study Documented Perchlorate in Products Derived from Chilean Caliche

EPA Survey of Fertilizers and Related Materials for Perchlorate (ClO_4^-)

Final Report

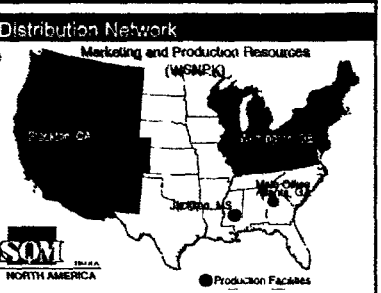
1.5 to 1.8 mg/g perchlorate detected in grab samples



Fertilizers are normally sampled by taking repeated cores through the piles using a Missouri D tube sampler The core samples are combined, riffled, divided, and analyzed. These practices are standard within the fertilizer industry and regulatory bodies Across the nation, state chemists or agriculture departments are obligated to examine fertilizers to verify the manufacturers reported grades Sampling practices have evolved to fill those needs Previous studies generally did not take these practices into account, concentrating instead on the analysis of the solid once a grab sample had been collected. Sampling is of course important to obtain representative results The distribution of perchlorate is not uniform in Chilean sodium nitrate For example in two lots with average concentrations of 1 5 and 1 8 mg g^{-1} individual 10.0-g grab samples ranged from 0.74 to 1.96 mg g^{-1} (Urbansky 2001) Information from previous studies and from standard industry practices was used to guide the study reported on in Chapter 2

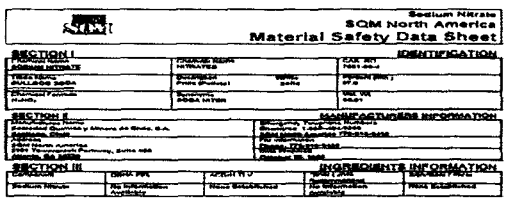
Chilean Nitrate Distribution Network Includes California

- Manufactured by SQM in Chile
- Distributed in USA under Bulldog brand
- Bulldog operating since 1831



"SQM North America sold some 75,000 tons to U.S. farmers in 1998" (EPA, 2001)

Chilean Nitrate Distributed by SQM/Bulldog



Sodium Nitrate
SQM North America
Material Safety Data Sheet

SECTION I IDENTIFICATION

SECTION II MANUFACTURER'S INFORMATION

SECTION III INGREDIENTS INFORMATION

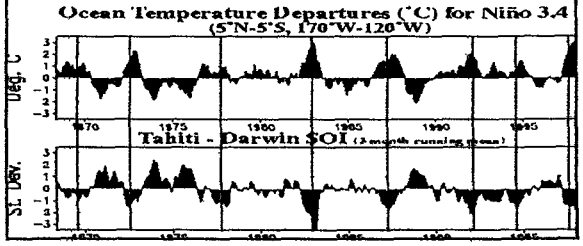
Natural Sodium Nitrate Specs mds

SQM is the largest producer of Sodium Nitrate in the world. Sodium Nitrate is extracted from natural deposits of Caliche Ore. The crushed Caliche is leached and the extracted soluble salts are crystallized. This process constitutes a unique source of natural Sodium Nitrate.

SQM Sodium Nitrate contains 16% nitrogen and many trace elements such as boron and magnesium. The main properties of these fertilizers are: fully water soluble, 100% nitrate nitrogen, alkaline reaction and fast nutrient release.

Chilean Nitrate Addresses Short-Term Nitrogen Deficiency Caused by Excessive Rain

- El Nino rain events cause soil flooding
  - N Deficiency
  - Crop Production Problems



Chilean Nitrate Addresses Short-Term Nitrogen Deficiency Caused by Excessive Rain

"...In 1998, El Nino's rainfall created extended periods of cold soil temperatures and excessive soil moisture (flooding in many areas) in Fresno County and counties farther south. So, in some years, N deficiency can result from cold soil and high rainfall, even in Southern California. Application of Chilean Nitrate can help reduce the production problems caused by this temporary nitrogen deficiency"

-Vice President, Agriculture, Small Planet Foods

Small Planet Foods

Chilean Nitrate Addresses Short-Term Nitrogen Deficiency Caused by Excessive Rain

Natural Sodium Nitrate Specs mds

SQM Specialty Field Fertilizers Project

SQM is the largest producer of Sodium Nitrate in the world. Sodium Nitrate is extracted from natural deposits of Caliche Ore. The crushed Caliche is leached and the extracted soluble salts are crystallized. This process constitutes a unique source of natural Sodium Nitrate.

SQM Sodium Nitrate contains 16% nitrogen and many trace elements such as boron and magnesium. The main properties of these fertilizers are: fully water soluble, 100% nitrate nitrogen, alkaline reaction and fast nutrient release.

Main uses

SQM Sodium Nitrate can be used effectively in soils and crops when a quick action top dressing nitrogen fertilizer is needed. All its nitrogen is available for immediate root absorption with no need to undergo chemical transformations. The quick acting nitrate nitrogen speeds up crop development and strengthens plant resistance to pests and diseases. These effects are particularly important at initial growth stages during cold springs.

For organic agriculture Sodium Nitrate is allowed to provide 20% of the total demand for Nitrogen (USDA Organic Rules).

- Readily available nutrients as in Sodium Nitrate assure better yields to high value crops
- Sodium Nitrate increase yield and quality of fruit orchards
- Nitrate nitrogen allows for a fast response in short season vegetables

Chilean Nitrate Popular as a Natural Fertilizer on the West Coast

- Readily available to crops
- Easy to apply
- Available on short notice

May 1 2002

National Organic Standards Board

I represent Grimmway Farms and Cal-Organic Vegetable Company in Bakersfield, Ca. Our companies have been farming organically since 1984 and are currently farming organic vegetables on over 18 000 acres. We'd like to ask for your assistance in supporting the use of Sodium (Chilean) Nitrate in organic farming.

Sodium (Chilean) Nitrate is a mined mineral from Northern Chile that has proven to be of vital importance in organic farming. The quick nitrogen release provided by this product is crucial in the growing of short duration crops and crops grown during cold season harvest. This product accompanied by compost at preplant along with other fertilizers (i.e. Processed Manures) is without a doubt absolutely necessary in the growing of organic vegetables. It also provides our products with the lasting capacity to whether long transportations to broader markets.

Chilean Nitrate Popular as a Natural Fertilizer on the West Coast

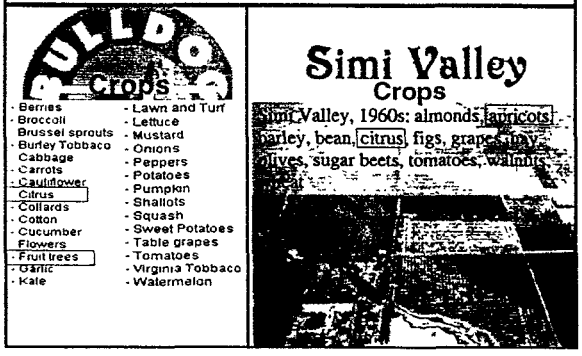
Small Planet Foods

September 3, 2002

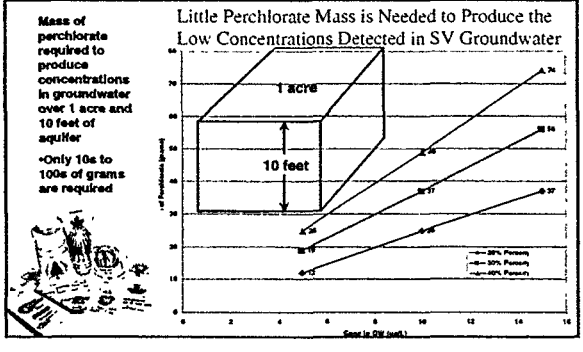
TO: National Organic Standards Board Members
National Organic Program, USDA

While there is a lack of science to support concerns about soil and environmental harm related to the use of Chilean nitrate, there is plenty of experience among organic farmers to support the need to retain this material as a fertilizer option for organic production. I have worked with west coast (California, Oregon, Washington) organic fresh market and processing vegetable growers (including tomatoes, corn, peas, green beans, carrots, potatoes, onions, lettuce, peppers, squash, broccoli, spinach, cauliflower, sugar snap peas, melons) since 1989. While all of these crops can be successfully grown without Chilean nitrate if the weather cooperates, it is common for at least one crop in the rotation (3 to 5 years) to need a Chilean nitrate application due to cold temperatures and/or wet soils that prevent adequate nitrogen release (from soil organic matter, compost, manure, etc.) for proper crop growth and maturity. Because such weather conditions cannot be predicted, it is difficult to plan for them. Chilean nitrate, used in accordance with Section 205.602(h) of the Final Rule, gives organic farmers a tool they need to prevent economic loss associated with nitrogen deficiency created by excessive rainfall and extended cold temperatures. Alternative nitrogen fertilizers are inadequate to address the timing, solubility, and application methods needed to mitigate the impact of these weather events.

Bulldog Markets Chilean Nitrate for Some Fruits and Vegetables Among Historic SV Crops



EPA: Chilean Nitrate Accounts for 0.1% of Total U.S. Fertilizer Use - How Can Fertilizer be a Perchlorate Source?

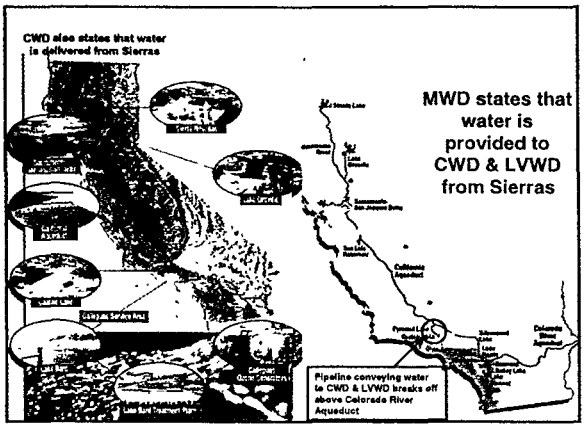


EPA: Chilean Nitrate Accounts for 0.1% of Total U.S. Fertilizer Use - How Can Fertilizer be a Perchlorate Source?

- **Case Study: Apply 5 pounds N per 1,000 square feet annually**
- **SQM sodium nitrate is 16% nitrogen**
  - **31.25 pounds SQM per 1,000 square feet annually**
- **SQM sodium nitrate contains ~1.5 mg perchlorate per gram fertilizer**
  - **21.3 grams perchlorate per 1,000 square feet annually**

Conclusion:

Local, small-scale Chilean Nitrate application is a very plausible source of perchlorate



Other Plausible Sources in Simi Valley Groundwater - Key Points

- **Perchlorate used in fireworks, road flares or naturally present in Chilean nitrate fertilizers are much more plausible reasons for the occurrences in Simi Valley Groundwater**
- **Colorado River water is not a plausible source**

Why isn't SSFL ClO_4 Source?
Topics to be Covered

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- Perchlorate Occurrence in Ahmanson Ranch Well M-1
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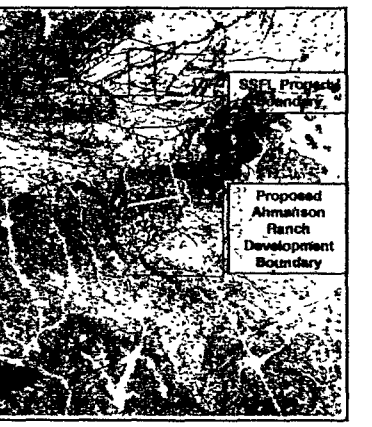
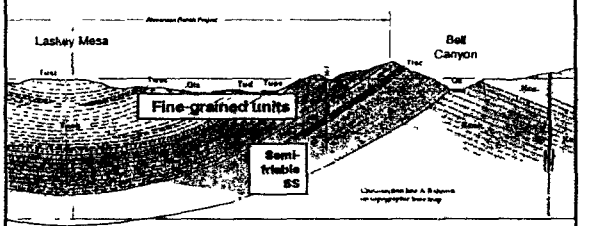
What is Known about Ahmanson Ranch Well M-1, Where Perchlorate was Detected?

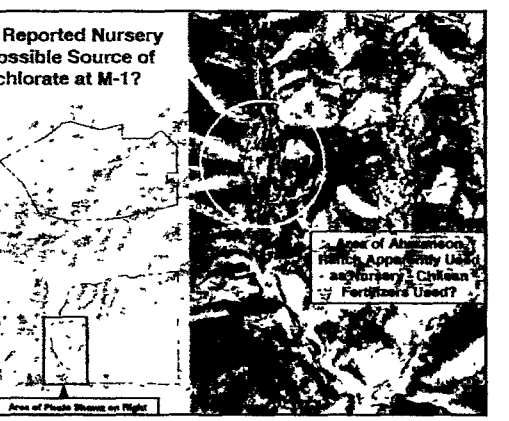


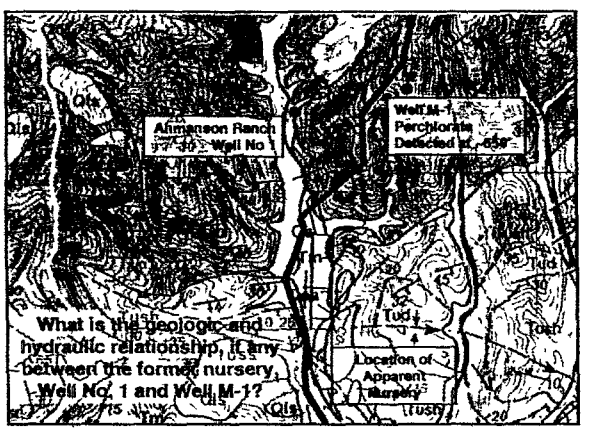
Approximate Stratigraphic Position of M-1, Projected on Section



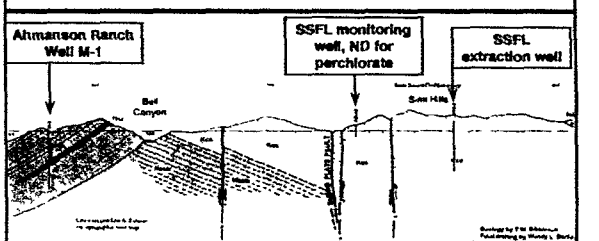
Well is artesian. Due to the presence of fine-grained units atop a semi-friable sandstone and the well penetrating the sandstone unit, which is under confined conditions?

Was a Reported Nursery the Possible Source of Perchlorate at M-1?





Geologic cross-section reveals the implausible transport of perchlorate from the SSFL to Ahmanson



In any event, it is implausible that the attenuated perchlorate diffused into the Chatsworth Formation, and influenced by decades of groundwater extraction would flow away from the extraction wells (located a thousand feet or so away from the SSFL sources), across three faults and to a well in a non-comformably placed formation 16,000 feet away

Perchlorate Occurrence in Ahmanson Ranch Well M-1 - Key Points

- **One detection in one sampling event is not confirmation that perchlorate is present in Ahmanson Ranch Well M-1**
- **Geology between SSFL and Ahmanson Ranch, attenuation of perchlorate associated with matrix diffusion, and groundwater capture from historical pumping of SSFL water supply wells show the groundwater flow pathway to be incomplete**

Why isn't SSFL ClO_4 Source? Topics to be Covered

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- Summary

Summary

<u>At the SSFL</u>

- SSFL used limited amounts of perchlorate because liquid propelled rocket engines were extensively tested, which resulted in TCE releases
- Perchlorate occurrences at SSFL are coincident with usages and are surrounded by sampling locations that do not contain perchlorate
- Perchlorate in SSFL groundwater is attenuated due to matrix diffusion, unlike granular aquifers

<u>In Simi Valley</u>

- The surface water transport pathway from SSFL to Simi Valley is incomplete as demonstrated by sampling results
- The distribution of perchlorate in Simi Valley groundwater is inconsistent with any plausible SSFL release scenario

Summary (Continued)

- Other plausible sources of perchlorate occurrences in Simi Valley include fireworks, road flares and Chilean nitrate fertilizers

<u>At Ahmanson Ranch</u>

- Geology between SSFL and Ahmanson Ranch, attenuation of perchlorate associated with matrix diffusion, and groundwater capture from historical pumping of SSFL water supply wells show the groundwater flow pathway to be incomplete
- Surface water pathway is incomplete because of separate and distinct drainages

Data and Scientific Analyses Demonstrate:

SSFL is <u>not</u> the Source of Perchlorate Occurrences in:

Simi Valley or at Ahmanson Ranch